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Ku et al.

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(54) **METHOD AND APPARATUS FOR IDENTIFYING A SUBSCRIBER HOME DOMAIN IN A COMMUNICATION NETWORK**

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H04L 29/08 (2006.01)

(52) **U.S. Cl.**
CPC **H04L 67/306** (2013.01); **H04L 65/1016** (2013.01); **H04L 65/1006** (2013.01); **H04L 65/1069** (2013.01); **H04L 65/1073** (2013.01)

(58) **Field of Classification Search**
USPC 370/259, 352
See application file for complete search history.

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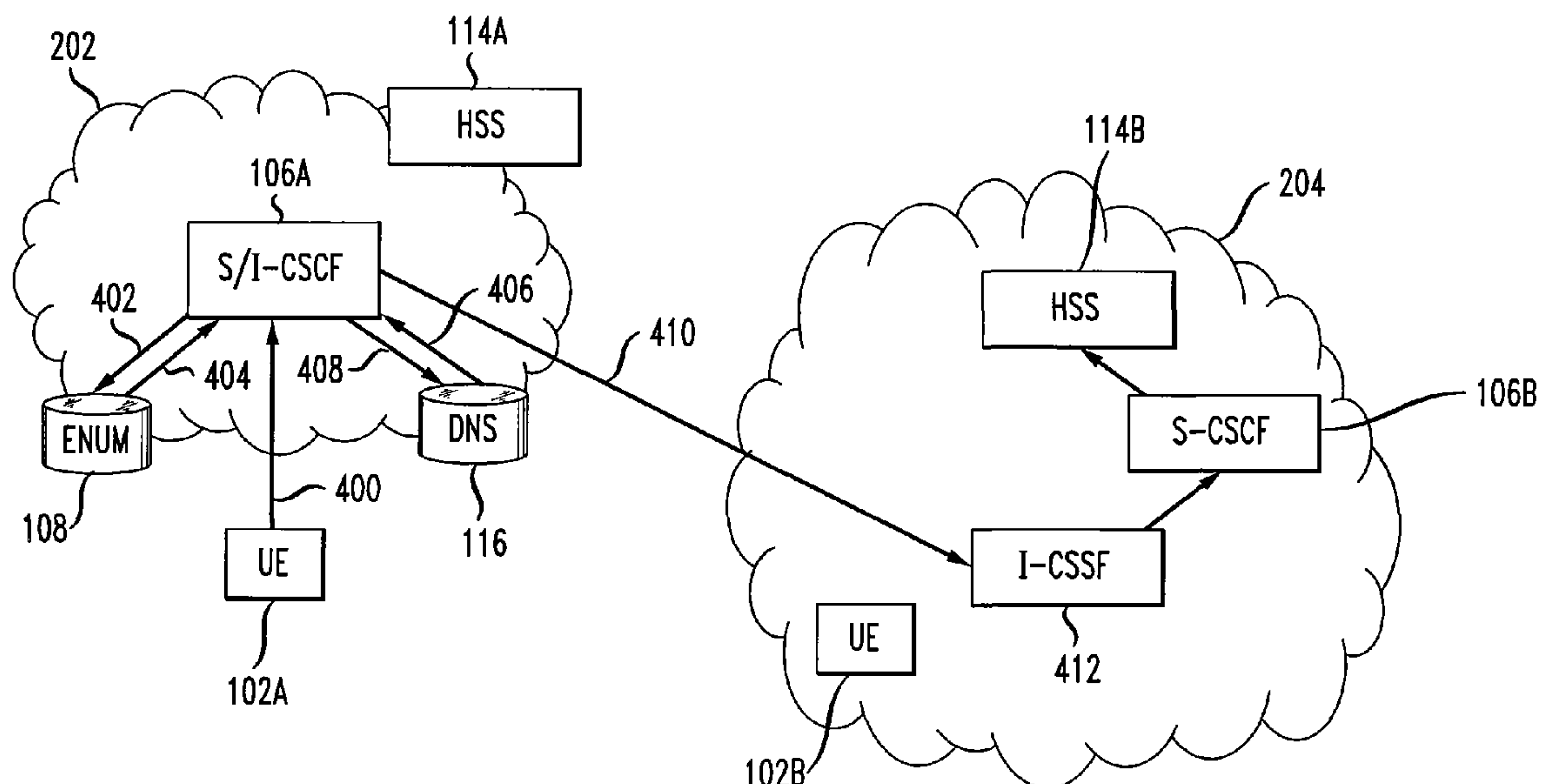
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(57) **ABSTRACT**

A method, apparatus and computer-readable medium for identifying a subscriber home domain in a communication network are described. A national subscriber profile is partitioned into regions and a NAPTR resource record is modified to identify in which region a particular subscriber is located. In response to a calling party requesting that a connection to a called party be established, a database is queried to provide a modified NAPTR record which identifies the region in which the called party is located. A connection can then be established without polling each region.

6 Claims, 6 Drawing Sheets



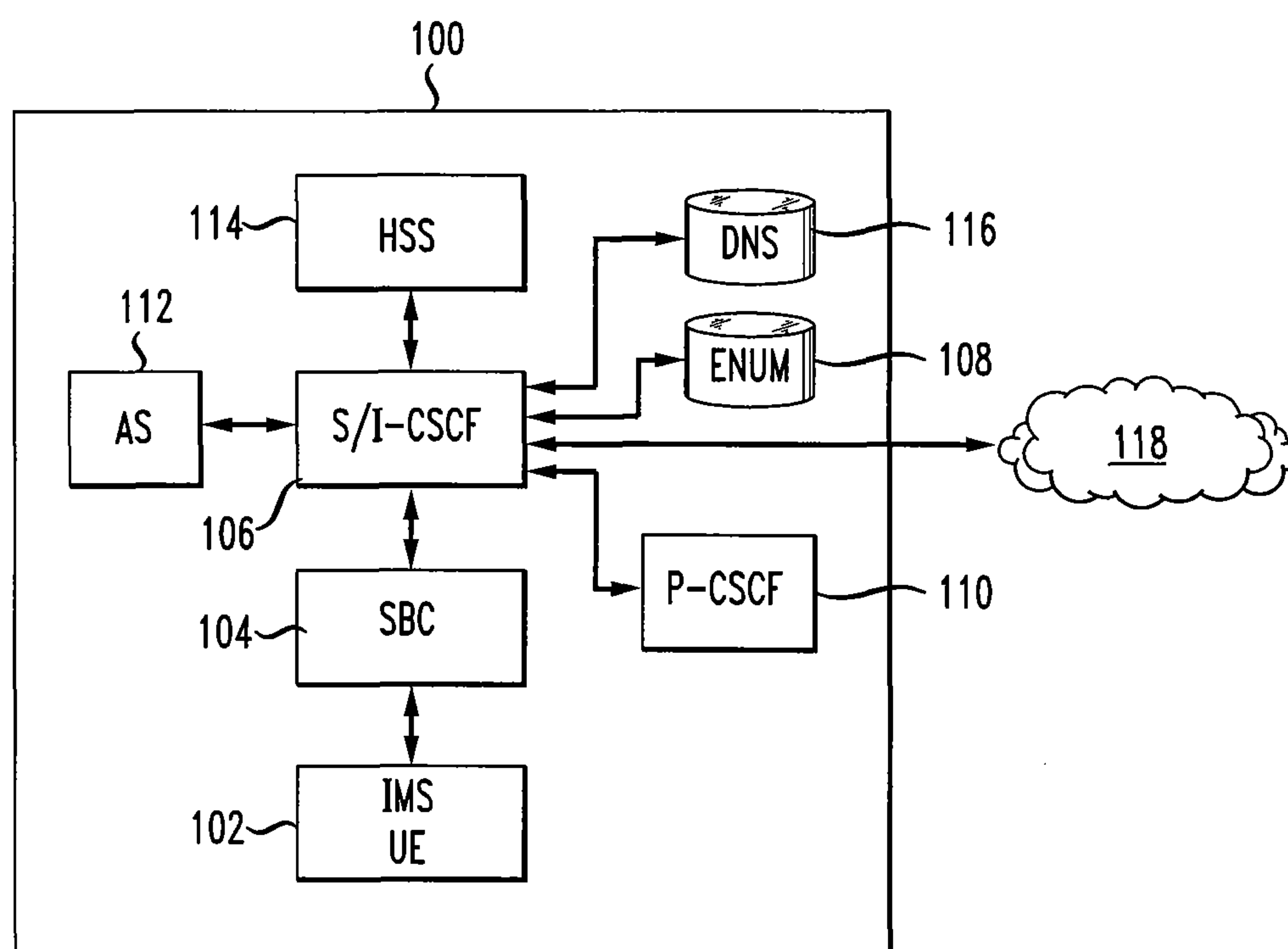
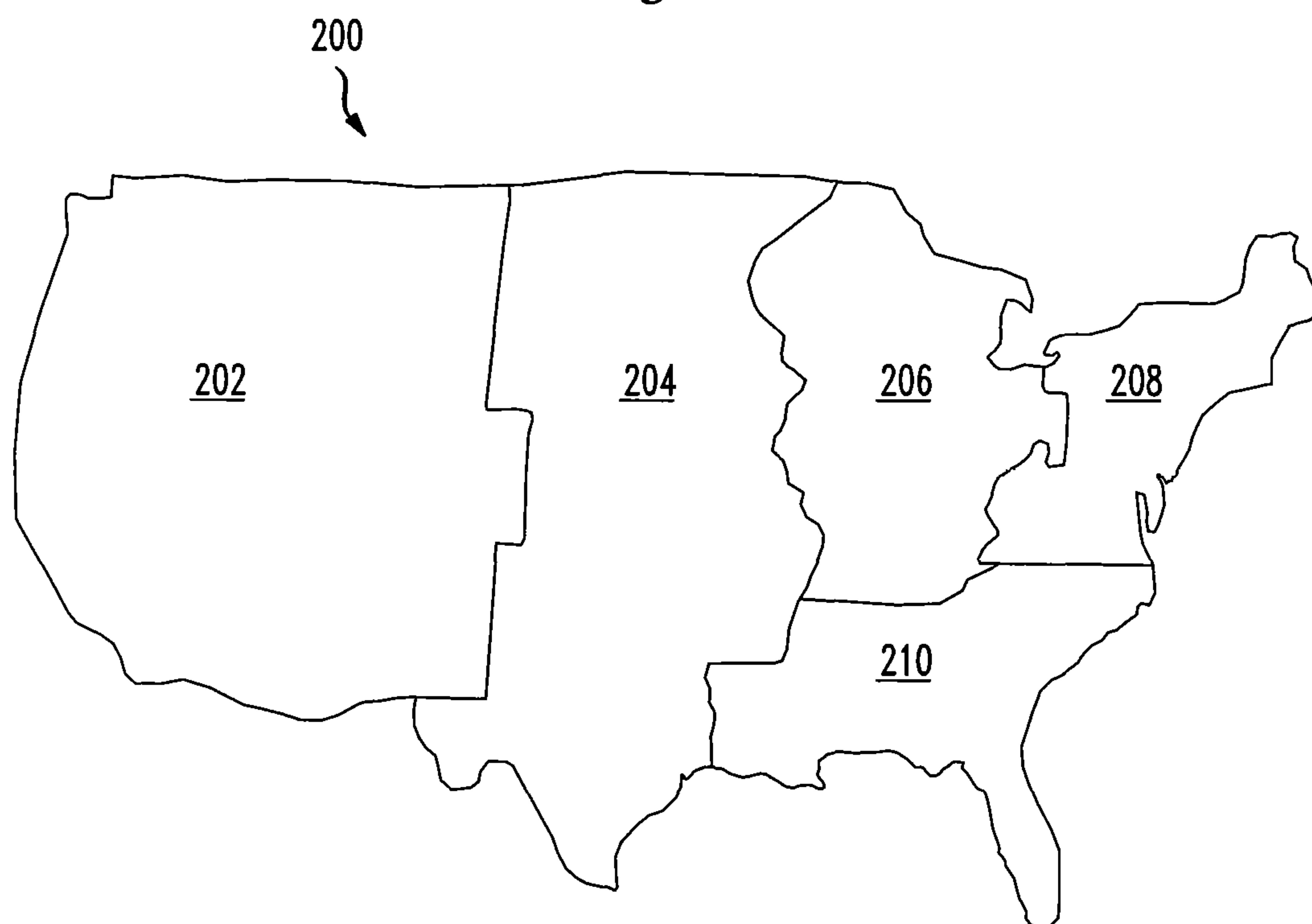


FIG. 1

FIG. 2



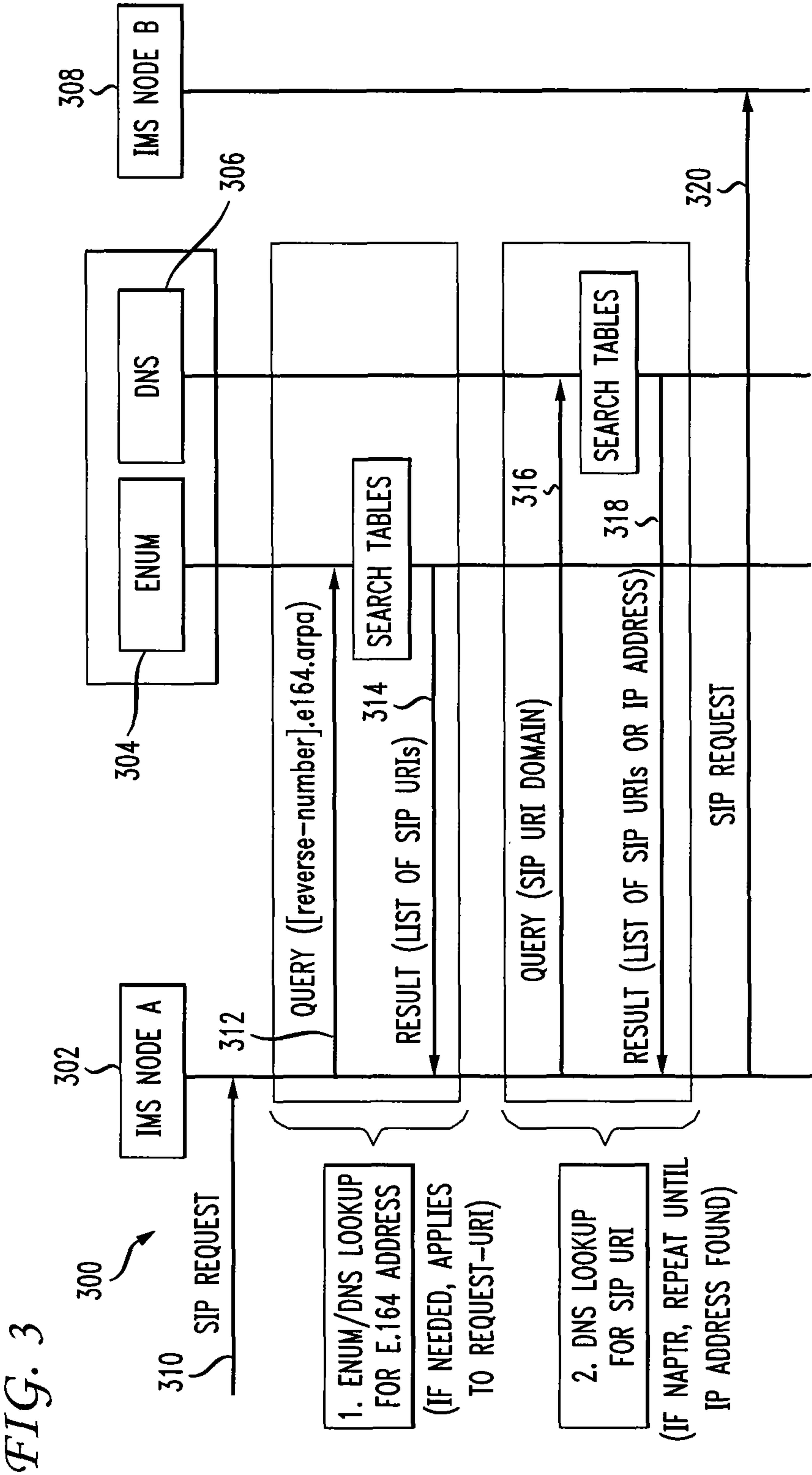


FIG. 4

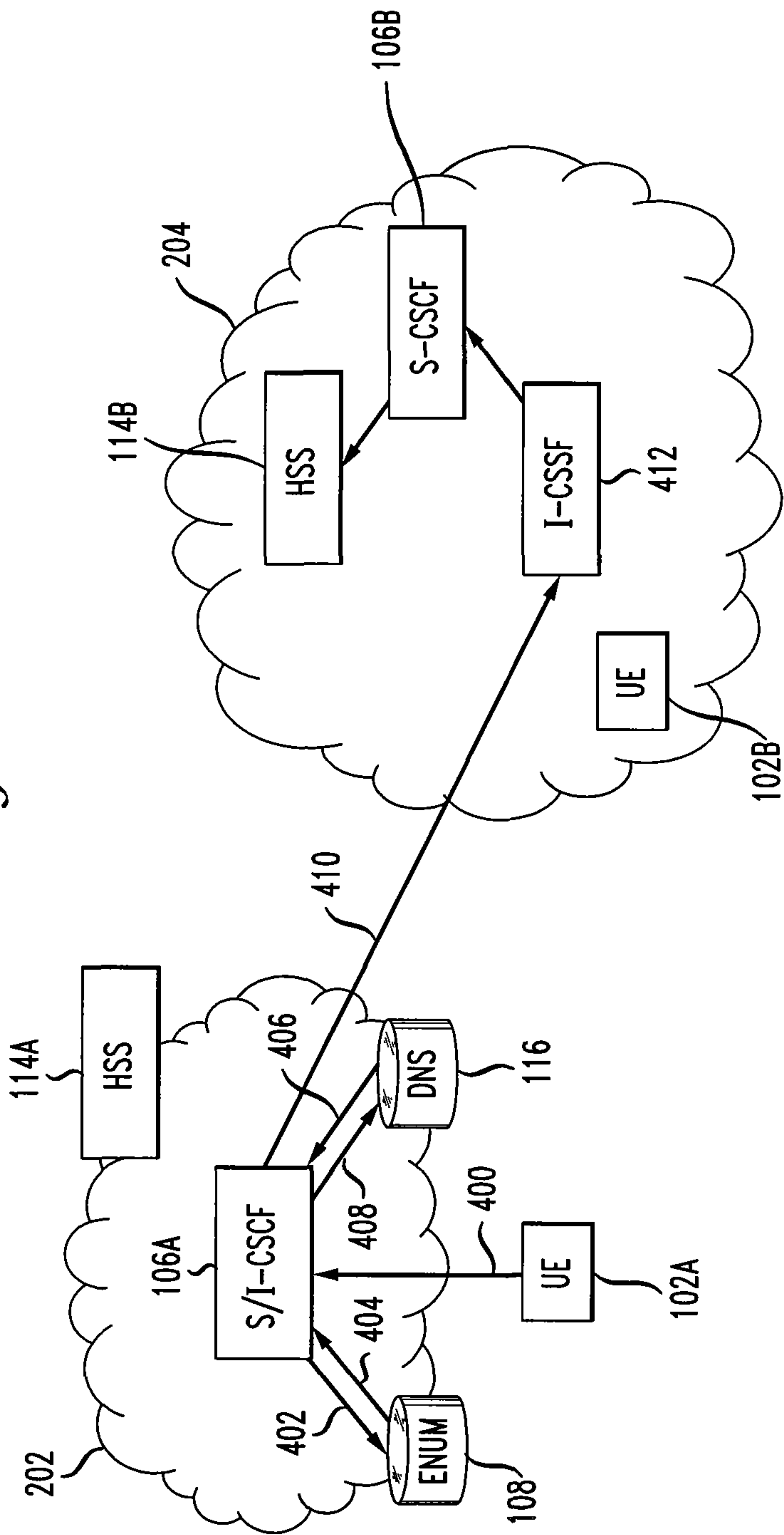


FIG. 5

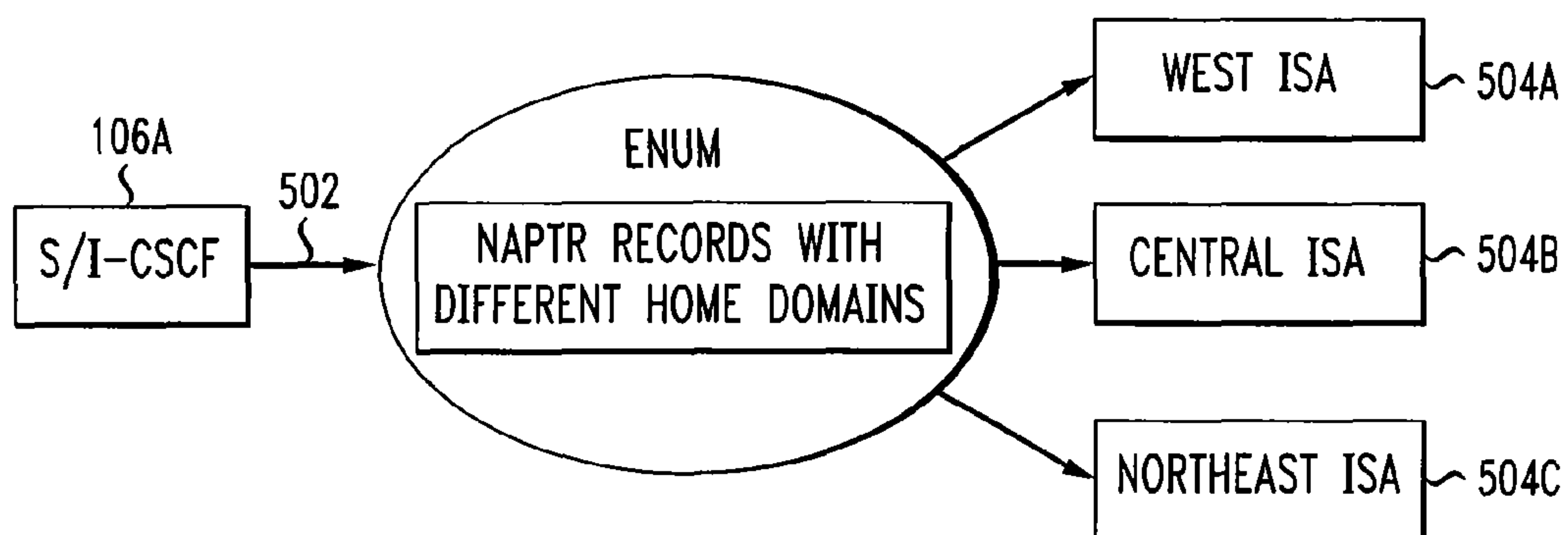


FIG. 6

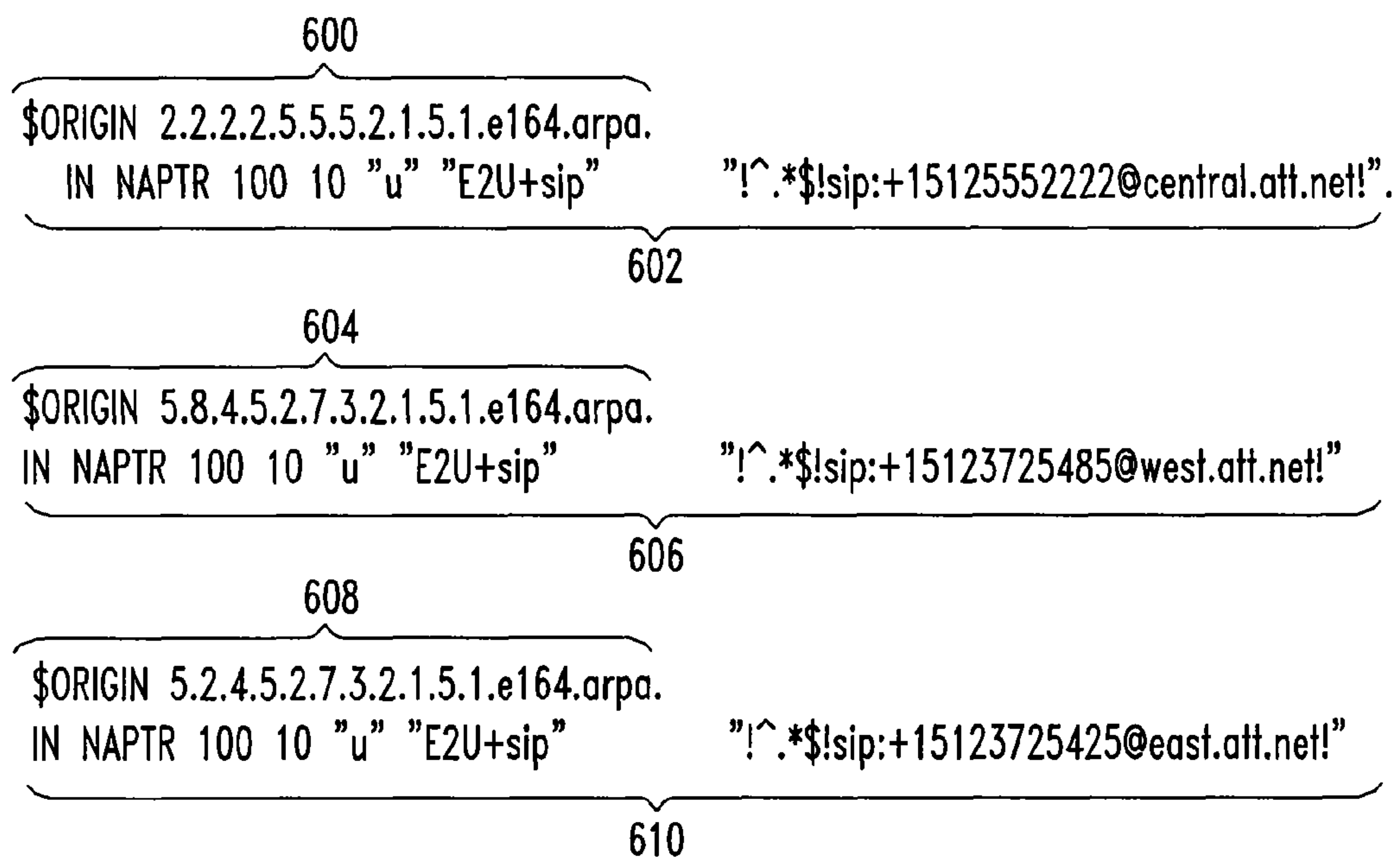
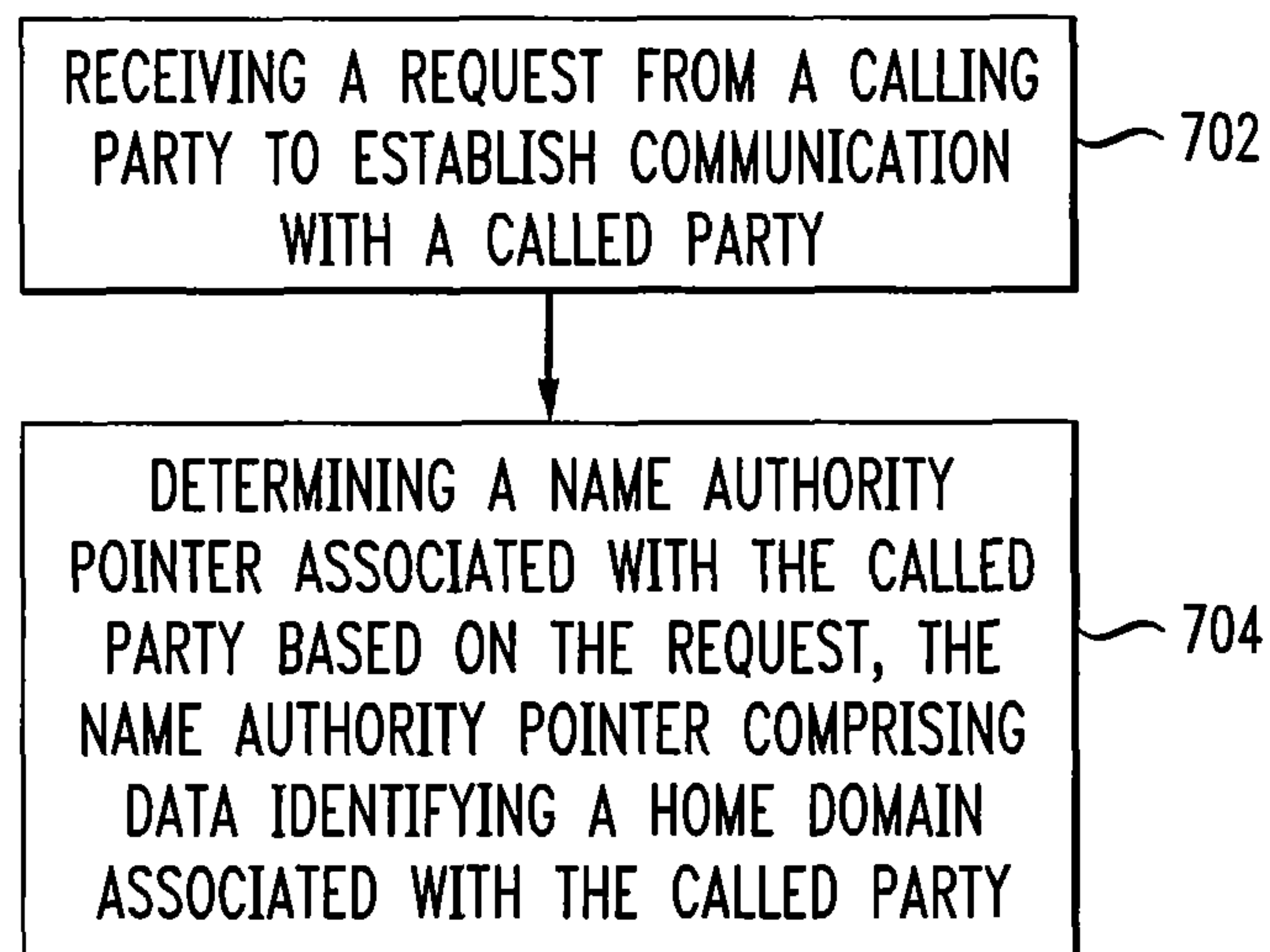
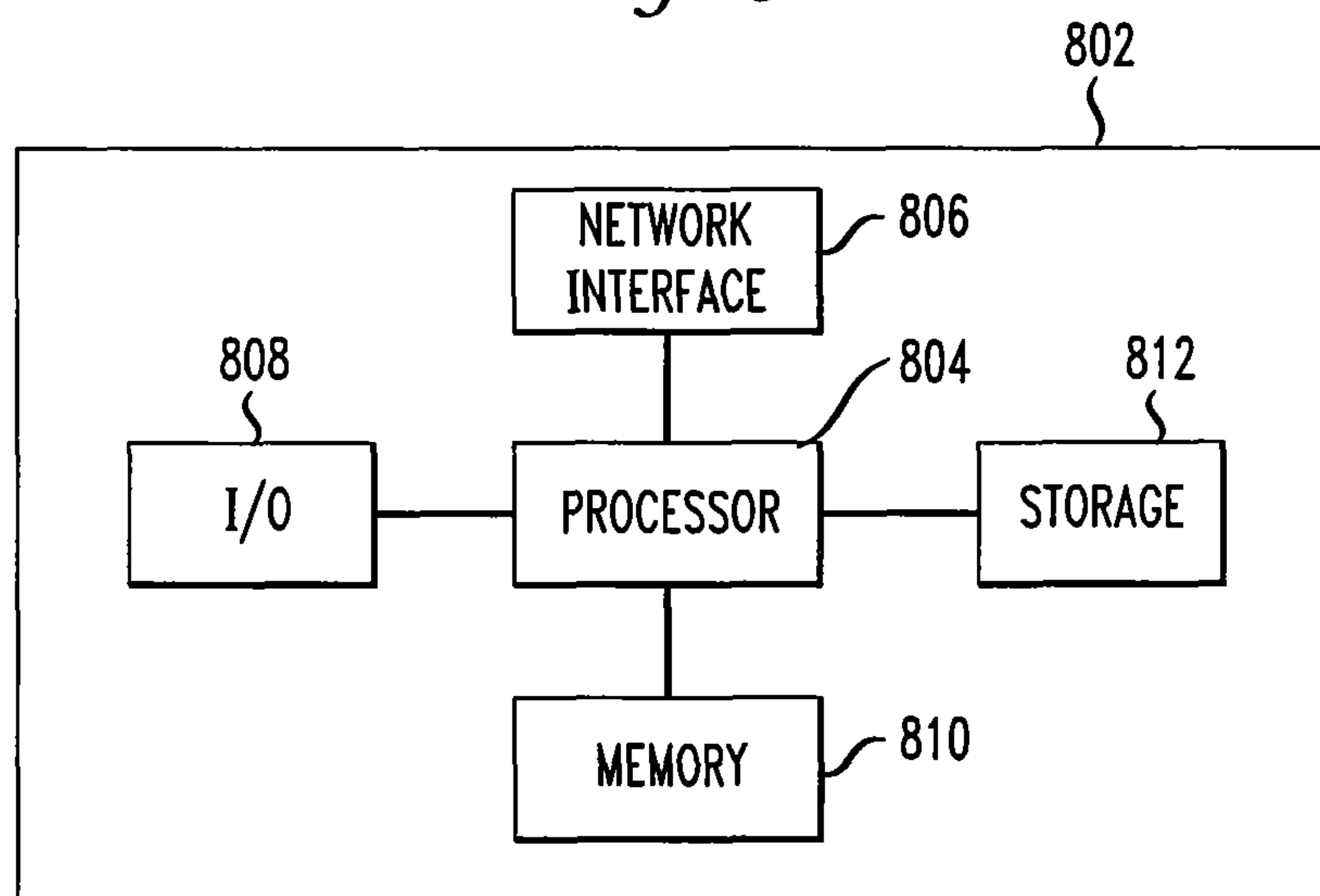


FIG. 7*FIG. 8*

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METHOD AND APPARATUS FOR IDENTIFYING A SUBSCRIBER HOME DOMAIN IN A COMMUNICATION NETWORK

FIELD OF THE DISCLOSURE

The present disclosure relates generally to communication networks and more particularly to IP Multimedia Subsystem (IMS) based Universal Voice Platform (UVP) for communications.

BACKGROUND

Subscribers in a communication network are generally each provided with a unique identifier. As the number of subscribers in a network grows, the potential time required to locate a particular subscriber increases. As the time required to locate a particular subscriber increases, the chances of an attempted connection failing increase as well. In addition, a large communication network may be comprised of smaller networks. When a particular subscriber is to be located, each of the smaller networks must be polled to determine if the particular subscriber is located in the smaller network. In addition to locating a particular subscriber, features that should be provided to a subscriber for a communication must be determined as well. This determination also increases the time required to establish a connection between two subscribers which also increases the chances of an attempted connection failing.

SUMMARY

In one embodiment, a method for determining a called party home domain in a partitioned network comprises receiving a request from a calling party to establish communication with a called party. A name authority pointer associated with the called party is determined based on the request and the name authority pointer comprises data identifying a home domain associated with the called party. The request can comprise an E.164 phone number associated with the called party. The name authority pointer associated with the called party can be determined by querying a database to determine the name authority pointer associated with the called party. A domain name of a device located in the home domain associated with the called party as well as an IP address of the device can also be determined. A request can be transmitted to the home domain associated with the called party based on the name authority pointer associated with the called party.

An apparatus for performing the above method and a computer-readable medium storing instructions for causing a computing device to perform operations similar to the above method are also disclosed.

These and other advantages of the general inventive concept will be apparent to those of ordinary skill in the art by reference to the following detailed description and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a high level block diagram of an IP Multimedia Subsystem (IMS) network for providing IP based multimedia services according to one embodiment;

FIG. 2 depicts a geographic area divided into a plurality of regions;

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FIG. 3 depicts a call flow diagram according to one embodiment;

FIG. 4 depicts a flow diagram illustrating the identification of a subscriber's home domain according to one embodiment;

FIG. 5 depicts a schematic of a component querying an ENUM database;

FIG. 6 depicts several queries and query results according to one embodiment;

FIG. 7 depicts a method of determining a subscriber's home domain according to one embodiment; and

FIG. 8 is a high-level block diagram of a computer for implementing components of the network shown in FIG. 1 and the methods of FIGS. 4 and 5.

DETAILED DESCRIPTION

FIG. 1 shows a high level block diagram of an IP Multimedia Subsystem (IMS) network **100** for providing IP based multimedia services. It should be noted that one or more functions (also referred to as components) may be run on a single implementer (i.e., specific hardware or node) and that various embodiments may have one or more functions distributed across a number of implementers or nodes. Functions, in one embodiment, are conventionally linked by standardized interfaces which allow communication between functions. Each of the functions of the system shown in FIG. 1 performs operations related to providing IP based multimedia services.

IMS UE **102** is an IP Multimedia User Equipment for a calling party. IMS User Equipment may comprise one or more of a variety of customer end point devices (e.g., wireline or wireless phones, personal computers, laptop computers, Personal Digital Assistants (PDAs), etc. IMS UE **102** is located in its respective IMS Network **100**. IMS UE **102** communicates with other functions in the IMS network **100** via Session Border Control (SBC) **104**.

SBC **104** performs session border control and functions to control the one or more data streams related to a particular IMS communication session. SBC **104** can include functionality (e.g. security related functionality) to control the flow of data between an internal and an external network. SBC **104** is used in some networks (such as VoIP networks) to exert control over the signaling and the media streams involved in setting up, conducting, and tearing down voice calls or other interactive media communications.

IMS network **100** includes multiple Session Initiation Protocol (SIP) servers which are known as Call Session Control Functions (CSCFs). The CSCFs are used to process SIP signaling packets and perform different functions.

Serving/interrogating Call Session Control Function (S/I-CSCF) **106** is the central node of IMS network **100** and is conventionally an SIP server. S/I-CSCF **106** performs session control functions and handles SIP registrations which relate user locations and SIP addresses. S/I-CSCF **106** can inspect every message and determine which application server or servers an SIP message should be forwarded to. S/I-CSCF **106** routes messages using tElephone NUMbering (ENUM) lookups. ENUM database **108** stores ENUM information pertaining to calling and called parties. There may be multiple S/I-CSCFs in a network in order to distribute communication session loads and increase availability. An S/I-CSCF is in communication with various IMS functions including Proxy-CSCFs (P-CSCFs, e.g., P-CSCF **110** of FIG. 1), Application Server (AS, e.g., AS **112** of FIG. 1), Home Subscriber Server (HSS, e.g. HSS **114** of FIG. 1), and Domain Name Server

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(DNS) database (e.g., DNS database **116**). An S/I-CSCF may be in communication with other devices in the IMS network as well.

Proxy Call Session Control Function (P-CSCF) **110** intercepts SIP INVITE messages and analyzes them to determine the desired called party and whether the messages contain logic requiring analysis by AS **112**. P-CSCF **110** can be a first point of contact for user equipment or can be in communication with UE **102** via a Session Border Controller (SBC) such as SBC **104** which can be used to implement some of the functionality of the P-CSCF. P-CSCF **110** may inspect every message from UE **102** and may also authenticate and establish a security association with UE **100** to prevent spoofing and replay attacks. Calling party and called party IMS networks typically each have their own P-CSCFs which can be in communication with user equipment, other CSCFs, and Application Servers (AS). P-CSCFs may be in communication with other devices in the IMS network as well.

Application Server (AS) **112** hosts and executes various services such as caller ID, call waiting, push to talk, etc. AS **112** may interface with S-CSCF **106** using Session Initiation Protocol (SIP) to provide these services and AS **112** may operate in different modes depending on the service provided. AS **112** may operate in SIP Proxy mode, SIP user agent mode, or SIP back to back user agent mode. An AS may be located in a home network, such as AS **108** shown in IMS network **100**, or in an external third party network.

A Home Subscriber Server (HSS), such as HSS **114**, is a master database that supports the IMS functions that actually handle communication sessions. HSS **114** contains information related to subscribers such as user profiles and performs authentication and authorization of a particular user.

A Domain Name System (DNS), such as DNS **116**, translates domain names into numerical identifiers such as in IP address. An IP address of a IMS function such as an Interrogating CSCF (I-CSCF) may be maintained a DNS allowing servers to locate a specific I-CSCF and use it as a forwarding point for messages.

IMS network **100** communicates with other IMS networks as well as other devices via network **118**. IMS network **100** can serve a particular group of users such as a group of users located in a particular geographic area.

FIG. 2 depicts a map **200** of the United States, in this embodiment, divided (also referred to as partitioned) into five regions designated as IMS Serving Areas (ISAs). The five regions are West ISA **202**, Central ISA **204**, Great Lakes ISA **206**, Northeast ISA **208**, and Southeast ISA **210**. The five regions together form a Universal Voice Platform (UVP) Regional Design which can be configured, in one embodiment, to carry Long Term Evolution (LTE) Voice data. The division of the geographic area into regions, along with additional modifications described herein, facilitate the identification of user/subscriber home domains for timely call completion. In one embodiment, access to a specific user profile associated with a subscriber also identifies appropriate call treatment (e.g., billing, features, etc.).

Each region shown in FIG. 2 has its own IMS network, such as IMS network **100** shown in FIG. 1. In order to determine a specific subscriber within a particular region, an S-CSCF queries its associated telephone Number Mapping (ENUM) and Domain Name Server (DNS) databases.

FIG. 3 depicts call flow diagram **300** in which an ENUM database and a DNS data base are queried to retrieve information. IMS Node A **302**, in one embodiment, is a S-CSCF, such as S-CSCF **106** shown in FIG. 1. ENUM **304** is a database, such as ENUM database **108** of FIG. 1, in which tables and records are stored, the tables and records indicating rela-

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tionships between E.164 addresses and Session Initiation Protocol Uniform Resource Identifiers (URIs), e.g. SIP URIs. DNS **306** is also a database, such as DNS database **116** of FIG. 1, in which tables and records are stored, the tables and records indicating relationships between URIs (e.g. SIP URIs) and IP addresses.

As illustrated in FIG. 3, an SIP request **310** is transmitted to IMS Node A **302** (e.g., S-CSCF). In response to SIP request **310**, IMS Node A **302** transmits a reverse number query **312** to ENUM **304** to search tables contained in ENUM **304**. In response to query **312**, ENUM **304** transmits a result **314** including a list of URIs based on data (i.e., an E.164 address) in SIP request **310**. In an illustrative example, reverse number query **312** can be "\$ORIGIN 2.2.2.2.1.1.1.2.1.5.1.e164.arpa" and in response, result **314** can be "NAPTR 10 100 "u" "E2u+sip" "!.*\$!sip:1+5121112222@example.com!" ".

Query **316** concerning an SIP URI domain is then transmitted from IMS Node A **302** to DNS **306**. In response to query **316**, DNS **306** transmits a result **318** including the IP address based on the domain "example.com" as included in the SIP URI to IMS Node A **302**. An SIP Request **320** is then transmitted from IMS Node A **302**, to IMS Node B **308** (e.g. I-CSCF of the caller's IMS network) based on the information obtained via queries **312,316**.

The flow diagram of FIG. 3 illustrates how a subscriber phone number can be used to determine additional identifiers for a particular subscriber. For example, a phone number "+1 (512) 555-5485" can be used to determine a Fully Qualified Domain Name (FQDN), such as "5.8.4.5.5.5.2.1.5.1.e164.arpa". The FQDN can then be used to query the associated Domain Name Server (DNS) to determine a Name Authority Pointer (NAPTR). The DNS server, in response, provides a list of Universal Resource Identifiers. For example, URIs such as "SIP:+15125552151@ims.uverse.att.net", "mailto:ku@lavs.buu.com", and "tel:+1-512-555-5000".

An ENUM, such as ENUM **108** contains tables and records associating E.164 numbers with NAPTR records. For example, a telephone number "+19725551234" can be used to generate the query "\$ORIGIN 4.3.2.1.5.5.5.2.7.9.1.e164.arpa" which can be used to query an ENUM database. In response the query "\$ORIGIN 4.3.2.1.5.5.5.2.7.9.1.e164.arpa", an ENUM database can return the following: "IN NAPTR 100 10 "u" "E2U+SIP" "!.*\$!sip:user@example.com!" wherein "IN" represents the query class, in this case Internet, "NAPTR" represents the query type, "100" represents the order, "10", represents the preference, "E2U+SIP" represents the resolution service (E164 to URL) and protocol, "!.*\$!" represents a greedy search, and "sip:user@example.com" represents the replacement NAPTR resource record for the next DNS resolution, and "!" is a delimiter. A query can return multiple NAPTR resource records identifying additional replacement NAPTR resource records with varying preferences. In one embodiment, the NAPTR resource record stored in ENUM **108** is modified to facilitate identification of a region in which a subscriber is located.

As shown in FIG. 2, a national subscriber profile can be partitioned into regions. Since the national subscriber profile is partitioned according to regions, the IMS core needs to know the home domain (CSCF and HSS of a called party) in order to inquire according to the called party. If the home domain of a particular called party is not known, call treatment related to the subscriber profile cannot be applied (i.e., additional services and features as well as billing arrangements can not be applied). Further, there will be a definite

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delay in the call processing and this delay will eventually cause all inbound and outbound calls to be dropped.

In order to implement the national subscriber profile shown in FIG. 2, the entire geographic area is divided into regions. Each region includes an IMS network **100** with an HSS, such as HSS **114** of FIG. 1, which does not communicate outside of its region. In one embodiment, there can be a master ENUM database and a local copy of the master ENUM database can be downloaded by each region. New IMS networks can be added to the national subscriber profile to facilitate growth. The national network can grow by adding regional IMS networks similar to IMS network **100** with supporting network elements such as P/S/I-CSCF, HSS, DNS, and ENUM.

In one embodiment, an ENUM-based resolution of multiple HSS/subscriber home domains is used to facilitate operations between regions (i.e., in one embodiment, the five regions shown in FIG. 2). S/I-CSCF can query an ENUM database which provides NAPTR resource records which are modified to include data identifying a region in which a subscriber is located. For example, a NAPTR resource record can be modified to include the identifier “@central.att.net” which indicates that the particular subscriber is located in Central ISA **204** of FIG. 2. More specifically, in response to querying an ENUM database containing modified NAPTR resource records with the query “\$ORIGIN 2.2.2.2.5.5.5.2.1.5.1.e164.arpa” the ENUM database returns “IN NAPTR 100 10 “u” “E2U+sip” “!.*\$!sip:+15125552222@central.att.net” wherein the “@central.att.net” identifies the region in which the subscriber identified in the query is located.

FIG. 4 depicts a flow diagram according to one embodiment in which a subscriber in one region is attempting to contact a subscriber located in a different region. S/I-CSCF **106A** is shown located in West ISA **202** (as shown in FIG. 2) and S-CSCF **106B** located in Central ISA **204**. It should be noted that although S/I-CSCF **106A** and S-CSCF **106B** are shown located in West ISA **202** and Central ISA **204**, respectively, the method described herein applies to any two S-CSCFs located in the same or different ISAs. UE **102A** is associated with a subscriber located in West ISA **202** who wants to communicate with UE **102B** which is associated with a subscriber located in Central ISA **204**. At step **400** (shown in FIG. 5) UE **102A** transmits a request indicating that the subscriber associated with UE **102A** wants to communicate with the subscriber associated with UE **102B**. In one embodiment, the request is a SIP Request (such as SIP Request **310** shown in FIG. 3). In response to receiving the SIP Request, at step **402**, S/I-CSCF **106A** transmits a query to ENUM database **108**. For example, S/I-CSCF **106A** can transmit the query “2.2.2.2.5.5.5.2.1.5.1.e164.arpa” to ENUM database **108**. In response to receiving the query from S/I-CSCF **106A**, ENUM database **108** determines a query result based on the query received. At step **404**, ENUM database **108** transmits a result, in this case, “E2U+Sip:sip:+15125552222@central.att.net”. It should be noted that the “@central.att.net” indicates that the subscriber associated with UE **102B** is located in Central ISA **204** and this additional information is contained in a modified NAPTR record or table stored in ENUM database **108**. At step **406**, S/I-CSCF **106A** transmits a DNS query, in this case “ICSCF@central.att.net”, to DNS **116**. In response, DNS **116** locates a record or table associated with I-CSCF **412** located in Central ISA **204** to determine the IP address of I-CSCF **412** which, in this example, is “12.1.1.20” and in step **408** transmits a response to the query of step **406** to S/I-CSCF **106A**. At step **410**, S/I-CSCF **106A** transmits an SIP Request to I-CSCF **412** identifying UE **102B** as the called party UE

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102A is trying to connect with. In response, I-CSCF **412** communicates with HSS **114B** via S-CSCF **106B** in order to determine call treatment associated with UE **102B**. A bearer connection between UE **102A** and **102B** can then be made in a conventional manner.

FIG. 5 depicts a schematic of S/I-CSCF **106A** querying ENUM **108** which, in response, provides NAPTR records modified according to one embodiment. S/I-CSCF **106A** transmits query **502** to ENUM **108**. Query **502**, in one embodiment, can be in a format such as “\$ORIGIN 2.2.2.2.5.5.5.2.1.5.1.e164.arpa”. In response to query **502**, ENUM **108** returns a NAPTR record specifying the home domain of the party identified in the query. For example, the NAPTR record can specify that the party identified in the query is located in a specific home domain as identified in query result **504A** as West ISA (e.g., West ISA **202** of FIG. 2), in query result **504B** as Central ISA (e.g. Central ISA **204** of FIG. 2) or in query result **504C** as Northeast ISA (e.g. Northeast ISA **208** of FIG. 2). It should be noted that ENUM **108** can receive queries from other network components including other CSCFs such as an I-CSCF or S-CSCF.

FIG. 6 depicts several examples of queries transmitted to an ENUM database, such as ENUM **108**, and query results in response to the queries. In response to query **600**, an ENUM database including modified NAPTR records returns query result **602**. Query result **602** contains “central.att.net” which identifies the home domain of the subscriber identified in query **600**. Similarly, query results **606** and **610** identify subscriber home domains “west.att.net” and “east.att.net” of the subscribers identified in queries **604** and **608** respectively. NAPTR records modified as described above facilitate the identification of a subscriber’s home domain.

FIG. 7 depicts a method according to one embodiment for determining a called party home domain in a partitioned network at a network component such as S/I-CSCF **106A** (shown in FIG. 4). At step **702**, the network component receives a request from a calling party to establish communication with a called party. In response, at step **704**, the network component determines a name authority pointer associated with the called party based on the request, the name authority pointer comprising data identifying a home domain associated with the called party. As described above, the determination of the home domain associated with the called party allows the network component to contact the identified home domain without polling all other home domains in the network.

As described above, modification of a NAPTR record prevents multiple attempts to locate a particular subscriber by identifying the region in which a particular subscriber is located. Without the modification of the NAPTR record and the methods described, subscribers would be located by querying multiple networks. In addition, after a subscriber is located, additional time to determine features the subscriber should be provided with is required. As a result, conventional methods used in attempting to connect two subscribers fail more often as the number of subscribers and sub-networks increases.

Components of IMS network **100** (e.g., IMS UE **102**, SBC **104**, S-CSCF **106**, ENUM **108**, P-CSCF **110**, AS **112**, HSS **114**, and DNS **116**) as well as the components depicted in FIGS. 3 and 4 and the methods depicted in FIGS. 4 and 7 may be implemented using a computer. A high-level block diagram of such a computer is illustrated in FIG. 8. Computer **802** contains a processor **604** which controls the overall operation of the computer **802** by executing computer program instructions which define such operation. The computer program instructions may be stored in a storage device **812**, or

other computer readable medium (e.g., magnetic disk, CD ROM, etc.), and loaded into memory **810** when execution of the computer program instructions is desired. Thus, the method steps of FIGS. **4** and **7** can be defined by the computer program instructions stored in the memory **810** and/or storage **812** and controlled by the processor **504** executing the computer program instructions. For example, the computer program instructions can be implemented as computer executable code programmed by one skilled in the art to perform an algorithm defined by the method steps of FIGS. **4** and **7**. Accordingly, by executing the computer program instructions, the processor **804** executes an algorithm defined by the method steps of FIGS. **4** and **7**. The computer **802** also includes one or more network interfaces **606** for communicating with other devices via a network. The computer **802** also includes input/output devices **808** that enable user interaction with the computer **802** (e.g., display, keyboard, mouse, speakers, buttons, etc.) One skilled in the art will recognize that an implementation of an actual computer could contain other components as well, and that FIG. **8** is a high level representation of some of the components of such a computer for illustrative purposes.

The foregoing Detailed Description is to be understood as being in every respect illustrative and exemplary, but not restrictive, and the scope of the inventive concept disclosed herein is not to be determined from the Detailed Description, but rather from the claims as interpreted according to the full breadth permitted by the patent laws. It is to be understood that the embodiments shown and described herein are only illustrative of the principles of the general inventive concept and that various modifications may be implemented by those skilled in the art without departing from the scope and spirit of the inventive concept. Those skilled in the art could implement various other feature combinations without departing from the scope and spirit of the inventive concept.

The invention claimed is:

1. A method for determining a called party home domain comprising:

partitioning a national subscriber profile covering a geographic area into a plurality of regions, each of the plurality of regions designated as internet multimedia subsystem serving area;

receiving a request, at a network component, from a calling party to establish communication with a called party of a plurality of parties, each of the plurality of parties associated with a respective internet multimedia subsystem serving area;

determining a name authority pointer associated with the called party by querying a local copy of a telephone numbering database in a home domain of the calling party based on the request, the name authority pointer comprising data identifying the called party home domain and a region of the plurality of regions of the national subscriber profile in which the called party is located;

determining a domain name of a device located in the called party home domain identified in the name authority pointer;

determining an internet protocol address of the device located in the called party home domain identified in the name authority pointer based on the domain name; and transmitting a request to the called party home domain based on the internet protocol address of the device located in the called party home domain.

2. The method of claim **1** wherein the request comprises an E.164 phone number associated with the called party.

3. An apparatus for determining a called party home domain comprising:

a processor; and

a memory to store computer program instructions, the computer program instructions when executed on the processor cause the processor to perform operations comprising:

partitioning a national subscriber profile covering a geographic area into a plurality of regions, each of the plurality of regions designated as internet multimedia subsystem serving area;

receiving a request from a calling party to establish communication with a called party of a plurality of parties, each of the plurality of parties associated with a respective internet multimedia subsystem serving area;

determining a name authority pointer associated with the called party by querying a local copy of a telephone numbering database in a home domain of the calling party based on the request, the name authority pointer comprising data identifying the called party home domain and a region of the plurality of regions of the national subscriber profile in which the called party is located;

determining a domain name of a device located in the called party home domain identified in the name authority pointer;

determining an internet protocol address of the device located in the called party home domain identified in the name authority pointer based on the domain name; and transmitting a request to the called party home domain based on the internet protocol address of the device located in the called party home domain.

4. The apparatus of claim **3** wherein the request comprises an E.164 phone number associated with the called party.

5. A computer-readable storage device storing computer program instructions for determining a called party home domain, which, when executed on a processor, cause the processor to perform operations comprising:

partitioning a national subscriber profile covering a geographic area into a plurality of regions, each of the plurality of regions designated as internet multimedia subsystem serving area;

receiving a request, at a network component, from a calling party to establish communication with a called party of a plurality of parties, each of the plurality of parties associated with a respective internet multimedia subsystem serving area;

determining a name authority pointer associated with the called party by querying a local copy of a telephone numbering database in a home domain of the calling party based on the request, the name authority pointer comprising data identifying the called party home domain and a region of the plurality of regions of the national subscriber profile in which the called party is located;

determining a domain name of a device located in the called party home domain identified in the name authority pointer;

determining an internet protocol address of the device located in the called party home domain identified in the name authority pointer based on the domain name; and transmitting a request to the called party home domain based on the internet protocol address of the device located in the called party home domain.

6. The computer-readable storage device of claim 5 wherein the request comprises an E.164 phone number associated with the called party.

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